BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

In the Matter of	)	
	)	
Duke Energy Progress, LLC, and	)	**DOCKET NO. E-100, SUB 179**
Duke Energy Carolinas, LLC, 2022	)	
Biennial Integrated Resource Plan	)	
and Carbon Plan	)	
	)	

DIRECT TESTIMONY AND EXHIBITS OF

TYLER FITCH

ON BEHALF OF

NORTH CAROLINA SUSTAINABLE ENERGY ASSOCIATION, SOUTHERN ALLIANCE FOR CLEAN ENERGY, NATURAL RESOURCES DEFENSE COUNCIL, AND THE SIERRA CLUB

September 2, 2022

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<u>EXHIBITS</u>

I. Introduction, Qualifications, and *Carbon-Free by 2050* Report

Q. PLEASE STATE YOUR NAME, ORGANIZATION, AND POSITION.

A. My name is Tyler Fitch. I am a Senior Associate with Synapse Energy Economics, Incorporated ("Synapse").

Q. PLEASE DESCRIBE SYNAPSE ENERGY ECONOMICS.

A. Synapse is a research and consulting firm specializing in energy and environmental issues, including transportation electrification, electric generation, transmission and distribution system reliability, ratemaking and rate design, electric industry restructuring and market power, wholesale electricity markets, stranded costs, efficiency, renewable energy, environmental quality, and nuclear power. Synapse's clients include state consumer advocates, public utilities commission staff, attorneys general, state energy offices, environmental organizations, federal government agencies, and utilities.

Q. SUMMARIZE YOUR WORK EXPERIENCE AND EDUCATIONAL BACKGROUND.

A. At Synapse, I conduct analysis and contribute to testimony and publications that focus on a variety of issues relating to the electricity system, including: integrated resource planning; ratemaking and rate design; system resilience; plant economics in organized energy markets; and electric vehicle (EV) market formation.

Much of my work is informed by modeling analyses of the electricity system. These may include spreadsheet- or Python-based analysis, or analysis using industry-standard electricity system models, such as EnCompass or the National Renewable Energy Laboratory's System Advisor Model.

Before joining Synapse, I worked at Vote Solar, where I led regulatory intervention on rate design, valuation of distributed energy resources, and resource planning in the Southeast. In my capacity as regulatory director at Vote Solar and Senior Associate at Synapse, I have provided expert testimony to public utilities commissions in Virginia, North Carolina, South Carolina, and Georgia. I hold a Master of Science from the University of Michigan and a Bachelor of Science in Environmental Sciences from the University of North Carolina at Chapel Hill. I provide a copy of my current resume, attached as Exhibit TF-1 to this testimony.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS CASE?

A. I am testifying on behalf of North Carolina Sustainable Energy Association, Southern Alliance for Clean Energy, Natural Resources Defense Council, and the Sierra Club (collectively, the Coalition of Low-Cost Energy and Net-Zero Intervenors or "CLEAN Intervenors").

Q. HAVE YOU TESTIFIED PREVIOUSLY BEFORE THE NORTH CAROLINA UTILITIES COMMISSION?

A. Yes. I previously provided testimony in Duke Energy Carolinas' and Duke Energy Progress' most recent rate cases (Docket Nos. E-7, Sub 1214 and E-2, Sub 1219).

Q. PROVIDE A VERY BRIEF OVERVIEW OF YOUR TESTIMONY.

A. My testimony is submitted pursuant to the North Carolina Utilities Commission's July 29 order allowing expert testimony on a number of topics related to the Commission's development of a Carbon Plan to meet North Carolina's House Bill 951 ("HB 951") carbon-reduction requirements.[1] This testimony draws from "Carbon-Free by 2050: Pathways to Achieving North Carolina's Power-Sector Carbon Requirements at Least Cost to Ratepayers" (the *"Carbon-Free by 2050* report"), which my team at Synapse prepared for the CLEAN Intervenors in this proceeding. Those parties included the *Carbon-Free by 2050* report as an attachment to their comments filed on July 20, 2022.[2] I also identify shared conclusions with other parties based on their previous submissions in this proceeding and respond to testimony submitted by Duke Energy witnesses.[3]

Q. HOW IS YOUR TESTIMONY STRUCTURED?

A. In Section 2, I briefly summarize my findings and recommendations for the Commission.

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[1] North Carolina Utilities Commission (2022, July). Order Scheduling Expert Witness Hearing, Requiring Filing of Testimony, and Establishing Discovery Guidelines. Docket No. E-100 Sub 179. Retrieved at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=8df88a56-f058-44e2-a40b-f9e712284b4a.

[2] Supplemental Joint Comments of NCSEA, SACE, Sierra Club, and NRDC (July 20, 2022). Docket No. E-100, Sub 179. Retrieved at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=6b9bc4ed-5c8d-4871-8393-072d0730100f.

[3] Although I do not respond to every point in other parties' previous filings that relates to issues covered in my testimony, that does not imply agreement or disagreement with those filings. For example, many findings in the Brattle Report filed by the Clean Power Suppliers' Association regarding the need for large-scale deployment of renewables and storage are directionally similar to the findings in my report.

Sections 3 through 7 are organized according to the issue categories identified in the Commission's July 29 order. In those sections, I discuss my findings and conclusions for issues related to "Modeling—Methodology, assumptions, and other modeling issues;" "Coal Unit Retirement Schedule;" "Near-Term Procurement Activity—Solar, Solar Plus Storage, Standalone Storage, Onshore Wind, Natural Gas Generation;" "EE / DSM / Grid Edge; and "Cost."

For each issue category addressed, I evaluate the proposed carbon plan filed with the Commission by Duke Energy Progress ("DEP") and Duke Energy Carolinas ("DEC," and together "Duke Energy," "Duke" or "the Companies") on May 16, 2022, describe the revisions made by Synapse in the *Carbon-Free by 2050* report, and describe the overall impact that these revisions had on our modeling results.

Q. PLEASE PROVIDE A BRIEF SUMMARY OF THE APPROACH USED TO PERFORM THE ANALYSIS IN THE *CARBON-FREE BY 2050* REPORT.

A. In preparing the *Carbon-Free by 2050* report, Synapse conducted capacity expansion and production cost modeling analysis of the combined Duke Energy system in the Carolinas to evaluate how Duke can cost-effectively meet North Carolina House Bill 951's carbon-reduction requirements while delivering power reliably. The analysis I used to develop the report relies on the same underlying EnCompass database that Duke used to develop the portfolios in its proposed carbon plan filing, with several important revisions. Specifically, my team modified several of Duke's model settings to better align with modeling best practices and we updated several inputs and assumptions to better represent current and likely future conditions. The *Carbon-Free by 2050* report explains these modifications and presents the new resource portfolios we developed based on these revisions to the model. These portfolios would achieve the required carbon reductions on time and more cost-effectively than any of Duke's proposed portfolios.

The *Carbon-Free by 2050* report includes three modeling scenarios. The *Duke Resources* scenario mimics the resource pathway identified by Duke Energy's Portfolio 1 with Alternate Fuel ("$P1_A$") in its proposed carbon plan filing,[4] using Synapse's revised inputs to better represent costs. Synapse selected the $P1_A$ portfolio as the basis for comparison because it is the only portfolio that meets the 2030 carbon-reduction requirement while assuming that firm transportation for Appalachian gas cannot be secured. This assumption avoids the operational risk of relying on firm gas transport that may not become available, while also avoiding the risk of failure to achieve the 2030 interim requirement. The *Optimized* scenario allows EnCompass to select the most cost-effective portfolio based on these revised inputs that continues to meet carbon-reduction and reliability requirements. Finally, the *Regional Resources* scenario uses the same settings as the *Optimized* scenario, but allows EnCompass to select Midwest wind resources, procured via power purchase agreements through the PJM Interconnection ("PJM"). The report

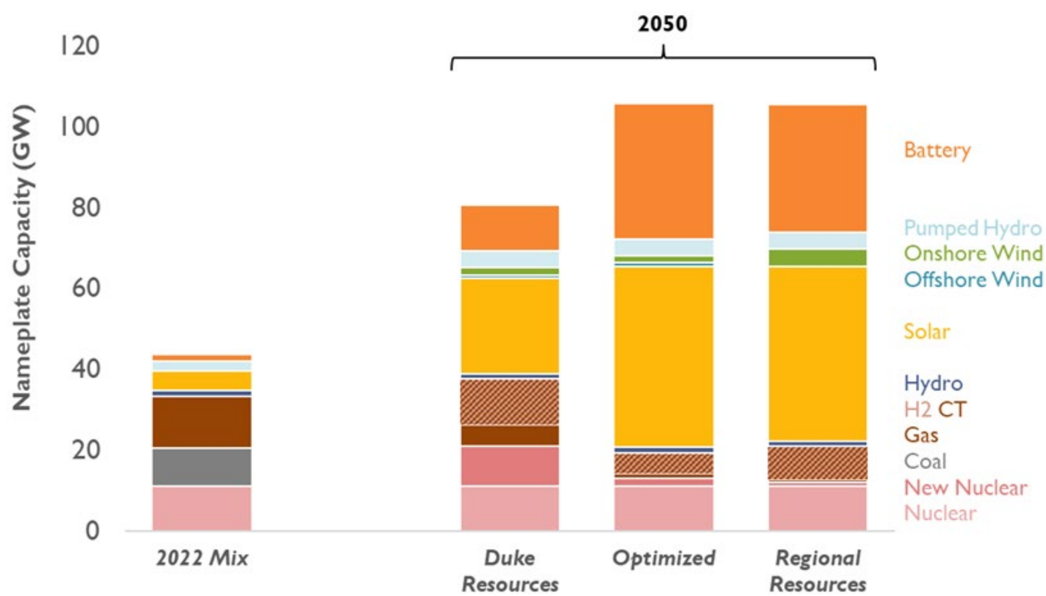
[4] Duke Energy Carolinas Carbon Plan Appendix E ("Appendix E"), p. 85.

also reviews several additional steps implemented by Duke in the development of their proposed carbon plan portfolios.

Q. PROVIDE A SUMMARY OF THE FINDINGS IN THE *CARBON-FREE BY 2050* REPORT.

A. The *Optimized* portfolio developed in EnCompass for the *Carbon-Free by 2050* report achieves HB 951's carbon-reduction requirements while delivering power reliably at a substantial savings compared to the portfolio produced by Duke Energy's $P1_A$ scenario. Figure 1, below, shows total capacity by resource type in 2022 and 2050 for each scenario modeled by Synapse.

Figure 1. Capacity by Resource Type, 2022 and 2050, by Scenario



Source: Carbon-Free by 2050 Report, p. 2.

Table 1, below, shows the net present value revenue requirements from 2022–2050 for each scenario.

Table 1. Net Present Value Revenue Requirement by Scenario

Results (2022-2050)	*Duke Resources*	*Optimized*	*Regional Resources*
2030 NPVRR ($B)	$36.7	$36.0	$34.3
2040 NPVRR ($B)	$77.7	$69.8	$65.8
2050 NPVRR ($B)	$121.2	$103.5	$98.1

Source: Carbon-Free by 2050 Report, p. 2.

Compared to the *Duke Resources* scenario, the portfolios developed by the *Optimized* and *Regional Resources* scenarios better utilize solar, storage, and energy efficiency resources through 2050, while avoiding investment in new gas, minimizing exposure to uncertain hydrogen and small modular nuclear technologies, maintaining the Companies' prescribed reserve margin, and serving 100 percent of load in all modeled hours. As a result, when compared to the *Duke Resources* portfolio, these portfolios achieve cost savings ranging from $700 million for the *Optimized* scenario and $2.4 billion for the *Regional Resources* scenario by 2030 to $17.7 billion for the *Optimized* scenario and $23.1 billion for the *Regional Resources* scenario by 2050.

II. Findings and Recommendations

Q. PLEASE SUMMARIZE YOUR FINDINGS ON ISSUES RELATED TO "MODELING—METHODOLOGY, ASSUMPTIONS, AND OTHER MODELING ISSUES."

A. My findings are as follows:

1. The Companies' capital cost projections favor gas and nuclear resources over solar and offshore wind resources when compared to reference cost forecasts;
2. Short-term differences in Synapse and Duke Energy gas price forecasts due to differences in when gas futures forecasts were

created underscore the commodity price risk to ratepayers inherent to gas-fired resources;

3. Enabling access to regional zero-carbon resources could unlock substantial savings for ratepayers;
4. Duke's transmission assumptions embedded in EnCompass constrain potential transmission solutions that could both benefit ratepayers and facilitate deployment of carbon-free energy resources;
5. Duke's analysis includes several inputs and assumptions that could lock in fossil resource investments, creating risk of noncompliance with HB 951 requirements and adding additional economic and operational risk;
6. Revised inputs used to develop the supplemental P5 and P6 portfolios only partially address faulty assumptions in Duke's modeling; and
7. Multiple issues with Duke's EnCompass data sharing process in this proceeding inhibited effective intervenor review and collaborative problem-solving.

Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS TO THE COMMISSION ON ISSUES RELATED TO "MODELING — METHODOLOGY, ASSUMPTIONS, AND OTHER MODELING ISSUES."

A. I recommend that the Commission direct the following steps in further Carbon Plan modeling:

1. To the extent that the Commission deems them necessary, implement reliability requirements as changes to model requirements rather than manual adjustments to model outputs;
2. Use capital cost estimates from all-source requests for proposals, where possible, and supplement with a neutral, industry-standard reference for capital cost projections for all technology types;
3. Consider purchases of cost-effective power from neighboring regions, including resources not to be owned by Duke Energy, to "shrink the challenge" of meeting net load with zero-carbon power;
4. Implement additional analyses that assess the potential benefit of additional transmission and regional coordination;
5. Make several changes to modeling inputs to avoid locking in costly legacy and fossil resources, including:
    a. a 2030 HB 951 compliance year,
    b. a 15-year or longer planning horizon,

c. a more realistic assumption about availability of "advanced" nuclear resources,
d. testing more realistic (higher) gas price forecasts,
e. more appropriate gas unit lifetimes,
f. removing "black out" years for off-shore wind, and
g. using more conservative estimates on hydrogen availability and retrofit feasibility;

6. Incorporate several modeling revisions related to the proposed changes in supplemental portfolios P5 and P6, including allowing storage in solar-plus-storage configurations to charge directly from the grid; co-optimizing carbon offsets at a higher price point (if the Commission deems inclusion of offsets appropriate), and utilization of a full-period capacity optimization.
7. Implement several changes to the Carbon Plan's EnCompass data sharing process in the future, focusing on allowing sufficient time for Duke and intervenors to build shared understanding and manage contingencies in sharing model data.

Q. PLEASE SUMMARIZE YOUR FINDINGS ON ISSUES AND RECOMMENDATIONS RELATED TO "COAL UNIT RETIREMENT SCHEDULE."

A. Duke Energy's manual adjustment of coal retirement dates lacks analytical justification and would result in additional costs to ratepayers.

I recommend that the Commission make all efforts to implement the most economic coal retirement dates for Cliffside unit 5, Marshall units 1 and 2, and Mayo unit 1, including evaluation of clean energy and zero-carbon resources to address transmission and generation concerns, in further development of a Carbon Plan.

Q. PLEASE SUMMARIZE YOUR FINDINGS AND CONCLUSIONS ON ISSUES RELATED TO "NEAR-TERM PROCUREMENT ACTIVITY — SOLAR, SOLAR PLUS STORAGE, STANDALONE STORAGE, ONSHORE WIND, NATURAL GAS GENERATION."

A. I find the following:

1. The Inflation Reduction Act ("IRA") will likely impact both the inputs and outputs of resource planning analysis conducted to date in this proceeding.
2. The *Carbon-Free by 2050's* short-term action plan focuses on flexible, modular solar and storage resources to chart a cost-effective, "no-regrets" pathway that will protect ratepayers from the risks associated with fuel price spikes and speculative technologies that have not yet been commercialized. Further, this no-regrets pathway is better positioned to take advantage of the cost reductions for solar, wind, and battery storage made possible by the IRA.

In light of those findings, I recommend that the Commission's Carbon Plan avoid procurement plans that would "lock in" resource or investment pathways, and instead, that the plan capitalize on no-regrets renewable resources that are expected to decrease in cost as the IRA is implemented. Therefore, I recommend that the Commission align near-term procurement plans with the cost-effective portfolios identified by the *Optimized* and *Regional Resources* scenarios and direct the Companies to bolster their ability to interconnect solar and storage resources in the short term.

Q. PLEASE SUMMARIZE YOUR FINDINGS AND RECOMMENDATIONS ON ISSUES RELATED TO "EE / DSM / GRID EDGE."

A. Duke Energy's base and high energy efficiency targets are below many of its industry peers. Ratepayers could save as much as $2.9 billion through additional investment in energy efficiency.[5]

Accordingly, I recommend that further Carbon Plan modeling expand incremental efficiency savings targets to 1.5 percent of total retail

[5] Carbon Free by 2050 Report, Table 10: Net Present Revenue Requirement over Time, Energy Efficiency Sensitivities p. 27.

load and invest in utility energy efficiency programming to achieve that target.

Q. PLEASE SUMMARIZE YOUR FINDINGS ON ISSUES RELATED TO "COST."

A. The *Duke Resources* portfolio (which, as explained previously, simulates Duke Energy's $P1_A$ portfolio using Synapse's revised cost estimates) would cost ratepayers $121.2 billion on an NPVRR basis through 2050.[6] Using those same revised cost estimates, the *Optimized* and *Regional Resources* portfolios presented in the *Carbon-Free by 2050* report would cost $103.5 billion and $98.1 billion, respectively.

III. <u>Issues Related To "Modeling — Methodology, Assumptions, and Other Modeling Issues"</u>

A. Duke Energy's Post-Modeling Manual Changes to Portfolios Deviate from Best Practices and Create Costs for Ratepayers.

Q. BRIEFLY SUMMARIZE THE MANUAL CHANGES MADE BY DUKE ENERGY TO THE PORTFOLIOS INCLUDED IN ITS PROPOSED CARBON PLAN FILING.

A. Duke Energy over-rode EnCompass's ability to optimize for the most economic resource selections in three ways: First, Duke manually delayed the coal retirement dates that EnCompass identified as economically optimal. Second, it replaced several hundred megawatts ("MW") of battery storage with gas combustion turbines. And third, Duke manually added gas combustion turbines and small modular nuclear reactors based on

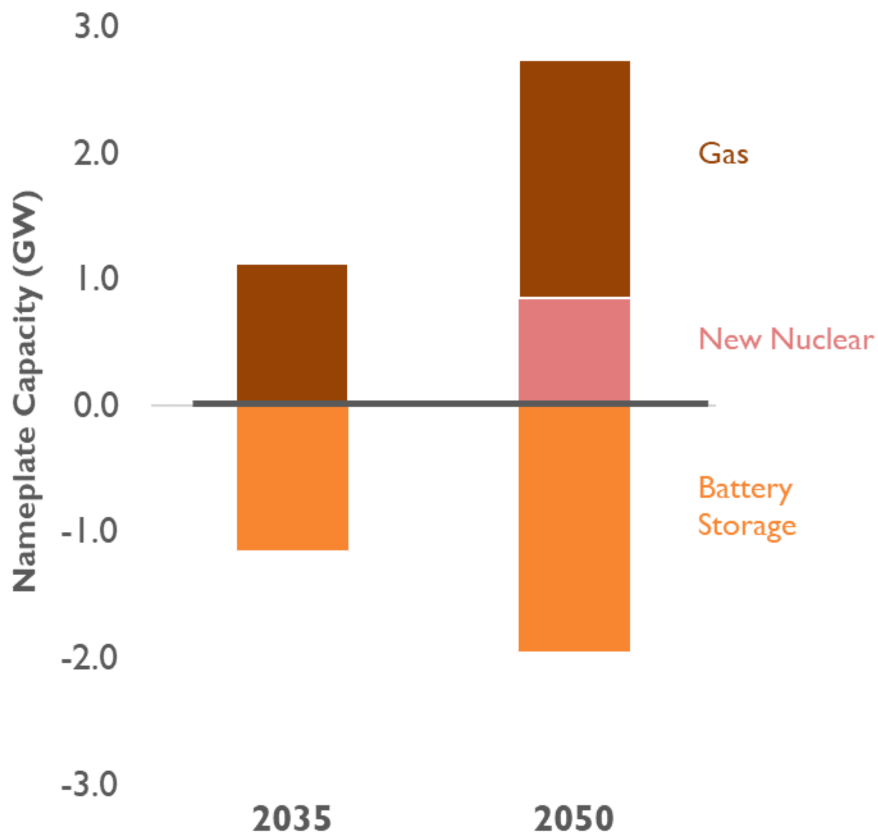
[6] By comparison, Duke reported that this portfolio ($P1_A$) would only cost $104.1 billion.

supplemental resource adequacy analyses.[7] The resulting portfolios differ substantially from the economically optimal portfolio identified by EnCompass.

Q. WHAT WAS THE CUMULATIVE IMPACT OF THOSE CHANGES?

A. Figure 3 shows the cumulative effect of Duke Energy's changes to its EnCompass modeling results on Duke's proposed Portfolio 1.

Figure 2. Manual Changes to Duke Energy Carbon Plan Portfolio 1 through 2035 and 2050



Source: Carbon-Free by 2050 Report, p. 35.

[7] Pages 27-35 of the *Carbon-Free by 2050* report include a more comprehensive description of Duke Energy's manual adjustments.

Through 2035, Duke Energy's overrides to EnCompass cause an additional 1 gigawatt ("GW") of gas combustion turbines to be added to the system, at the expense of 1 GW of battery storage technologies. By 2050, these manual changes result in the addition of nearly 3 GW of gas and nuclear capacity, and the removal of 2 GW of battery storage capacity. These new gas plants would then need to be converted to burn 100 percent zero-carbon hydrogen, when it is not yet known whether that conversion is feasible, or what the cost will be. Any new nuclear plants would rely on technologies that are not commercially available today. For context, 2022 generation capacity across DEC and DEP is roughly 40 GW; these manual revisions represent an eighth of 2022 generating capacity.

Q. PROVIDE YOUR EVALUATION OF WHETHER THESE CHANGES ARE CONSISTENT WITH BEST PRACTICES IN RESOURCE PLANNING.

A. No, they are not. The EnCompass economic optimization algorithm works by testing thousands of potential resource portfolios and identifying which are able to meet environmental requirements (e.g., carbon limits), energy and capacity needs, and reserve margin and reliability requirements most cost-effectively. Manual changes to the resource portfolios identified by the model are, by definition, a deviation from the economically optimal portfolio identified by EnCompass and are therefore likely to result in increased costs to ratepayers. The selective nature of the Companies' manual overrides (i.e., replacing battery storage resources with gas combustion turbines and, in some cases, new nuclear resources) underscores the departure from objective, resource-neutral economic optimization. Tech

Customers[8] and the Attorney General's Office ("AGO") Strategen Report[9] similarly express concerns in their reports that Duke's manual constraints and "out of model adjustments" limit the utility of its modeling and result in non-optimal results.

Q. SUMMARIZE DUKE'S JUSTIFICATIONS FOR THESE CHANGES AND PROVIDE YOUR RESPONSE.

A. Duke Energy justifies these manual changes based on the results of several post-EnCompass analyses.[10] Duke witnesses Glen Snider, Bobby McMurry, Michael Quinto and Matt Kalemba ("Snider et al.") frame capacity expansion modeling as a "first screen"[11] and claim that the additional analytical steps taken by Duke are "necessary" for demonstrating reliability.[12]

I agree with the Duke witnesses that the capacity expansion model is not the *only* necessary tool for resource planning, but I would add that it is the best tool for identifying an economically optimal resource mix. As explained in the *Carbon-Free by 2050* report, a resource-neutral way to ensure reliability would be to change the reliability requirement

[8] Gabel Associates (2022, July). Review of the Duke Carbon Plan and Presentation of a Preferred Portfolio. Prepared for Tech Customers ("Tech Customers Gabel Report"). Gabel report, pp. 10, 47-48.
[9] Strategen Consulting (2022). Analysis of the Duke Energy 2022 Carbon Plan. Prepared for the North Carolina Attorney General's Office ("AGO Strategen report"), pp. 8-10.
[10] Pages 30-34 of the *Carbon-Free by 2050* provide a summary of these post-EnCompass analyses.
[11] Direct Testimony of Glen Snider, Bobby McMurry, Michael Quinto and Matt Kalemba for Duke Energy Carolinas, LLC and Duke Energy Progress, LLC, p. 91, ll. 11-12.
[12] *Ibid.,* p. 197, ll. 4-6.

requirements of the capacity expansion model, rather than manipulating the outputs.[13] This could include, for example, changes to planning reserve margin levels or seasonality, proposing different effective load carrying capability ratings to different resources, or even using a more detailed daily load curve for capacity expansion modeling. Instead, the approach taken by Duke in its portfolio development departs from the resource-neutral, cost-optimal approach.

I do not agree with the Duke witnesses' assertion that the Companies' post-modeling changes are commonly understood as a necessary step in resource planning. The DEC and DEP 2020 Integrated Resource Plans ("IRPs"), for instance, do not include any "Resource Adequacy and Reliability Verification" step that incorporates additional runs of the Strategic Energy & Risk Valuation Model ("SERVM") after the capacity expansion model runs.[14] Instead, the IRPs describe, in detail, the resource adequacy study conducted by Astrapé and the selection of the 17 percent reserve margin--both of which informed the inputs to the IRPs, rather than any changes to the outputs.[15]

Duke witnesses were only able to identify one other IRP that conducted a similar analysis, which was Public Service New Mexico's

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[13] *Carbon-Free by 2050* report, pp. 32-33.
[14] Duke Energy Carolinas Integrated Resource Plan 2020 Biennial Report, pp. 63-75.
[15] *Ibid.*

("PNM") 2020 IRP.[16] PNM's use of SERVM in that planning process differs from Duke's in several ways, however:

3. PNM's SERVM analysis is done at multiple levels of assumed regional coordination, rather than assuming no regional coordination;
4. PNM uses SERVM analysis of this type to characterize potential future resource adequacy issues, rather than as a justification for any manual changes to resource portfolios;
5. PNM's "No New Combustion" portfolio meets 2040 loss of load expectation standards under base-case regional imports assumptions.

Thus, the configuration, analytical function, and results of this analysis are not consistent with Duke's use of SERVM as a post-optimization portfolio editing tool.

Q. PROVIDE YOUR PERSPECTIVE ON SNIDER ET AL.'S USE OF THEIR SERVM LOSS OF LOAD EXPECTATION ANALYTICAL MODEL ON INTERVENOR PORTFOLIOS.[17]

A. As with their own portfolios, the Companies' use of SERVM in this way lacks analytical justification and departs from best practices used in other resource planning processes. It also effectively undoes the increased transparency afforded by using the EnCompass tool by introducing another "black box" into the analytical pipeline, as identified by the AGO Strategen report.[18]

Q. BASED ON THIS FINDING, WHAT ARE YOUR RECOMMENDATIONS TO THE COMMISSION?

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[16] Snider et al., p. 95.
[17] Snider et al., pp. 202-205.
[18] AGO Strategen Report, pp. 9-10.

A. I recommend that the Commission reject the manual changes made by Duke to its portfolios because they deviate from least-cost resource planning and lack an economic or resource adequacy justification. If the Companies believe that additional reliability or resource adequacy analyses are necessary, they should implement these in advance of capacity expansion modeling (via resource adequacy studies and/or effective load carrying capability studies) and allow optimization software to choose the most economic resource pathway that meets reliability requirements. At present, the manual revisions add dependence on gas and nuclear resources with no clear benefit to ratepayers.

B. Compared to Industry-Standard References, Duke's Capital Cost Projections Tilt the Playing Field Toward Nuclear and Gas Resources.

Q. HOW DO DUKE'S COST ASSUMPTIONS COMPARE TO THOSE THAT SYNAPSE USED IN ITS *CARBON-FREE BY 2050* REPORT?

A. Duke bases its capital cost forecasts on internal and external sources, including Guidehouse for renewable and storage costs, Burns & McDonnell for thermal costs, and energy consultants and manufacturers for other resources.[19] A Duke discovery response indicates that Duke sourced the BWRX small modular nuclear reactor capital cost forecast, for example, directly from the manufacturer.[20]

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[19] Duke Energy response to Public Staff Data Request 3-3. Although this response was confidential, counsel for Duke Energy confirmed that the information in the foregoing sentence could be presented in the public, unredacted version of this testimony.

[20] Duke Energy response to NCSEA-SELC Data Request 3-17.

Synapse's *Carbon-Free by 2050* uses the National Renewable Energy Laboratory's 2022 Annual Technology Baseline's ("NREL ATB") capital cost projections for solar, solar plus storage, on- and off-shore wind, and battery resources. For gas resources and small modular reactor ("SMR") nuclear units, Synapse used cost estimates from the Energy Information Administration's 2022 Annual Energy Outlook ("EIA AEO"). While the results of an all-source request for proposal ("RFP") would be the best source of market cost data in the near term, in the absence of this information, Synapse's use of publicly available, industry standard resources provides a benchmark against which to evaluate Duke's cost projections.[21]

Figure 4 shows a comparison between Synapse and Duke capital cost estimates for generation resources by technology:

[BEGIN CONFIDENTIAL]

[21] As an example, the South Carolina Public Service Commission directed Duke Energy to use NREL ATB cost forecasts in the Companies' 2020 Modified Integrated Resource Plans. *See:* South Carolina Public Service Commission Order No. 2021-447, retrieved at: https://dms.psc.sc.gov/Attachments/Order/28c909bb-889f-4095-b364-1ab8359ee799.

[redacted]

[END CONFIDENTIAL]

Duke's capital cost projections are relatively more expensive than the NREL ATB reference for standalone solar, solar plus storage, offshore wind and 4-hour storage resources. In contrast, Duke's estimates are less expensive than the EIA AEO reference for nuclear SMRs and gas combined-cycle and combustion turbine units. To an extent, deviations across different forecasts for individual resource projections are to be expected. However, the pattern of renewable costs that are higher than industry standards and conventional fossil and steam resource costs that are lower than industry standards presents cause for concern. The Tech Customers also expressed concern with Duke's cost projections favoring gas over renewable resources.[22]

[22] Tech Customers Gabel Report, p. 8.

Q. WHAT IMPLICATIONS DID THESE CAPITAL COST ASSUMPTIONS HAVE ON DUKE'S PROPOSED PORTFOLIOS?

A. Capital cost projections drive the selection of resources based on EnCompass' economic optimization. Differences in resource costs will therefore affect which portfolio EnCompass identifies as economically optimal. And of course, capital cost assumptions affect the total projected net present value revenue requirement of each portfolio.

Q. PROVIDE YOUR RESPONSE TO DUKE'S WITNESSES' CLAIMS THAT CAPITAL COST ASSUMPTIONS USED IN THE *CARBON-FREE BY 2050* REPORT ARE INAPPROPRIATE.[23]

A. Synapse's analysis used industry-standard, publicly available capital cost projections developed by expert U.S. government researchers. For gas-fired resources, our team confirmed that our approach was consistent with the approach used by Duke for applying EIA AEO price forecasts in its own analysis.[24] We deliberately sourced our capital cost inputs to maintain transparency and neutrality in resource selection.

Q. WHAT ARE YOUR RECOMMENDATIONS TO THE COMMISSION WITH REGARD TO CAPITAL COST ASSUMPTIONS?

A. Given the impact of capital cost projections on modeling results and selected portfolios, utilities and regulators should ensure that cost projections are publicly available, high-quality, and neutral across resources. To achieve this, the Commission should direct Duke to issue regional, all-source RFPs for energy and capacity resources for use in

[23] Snider et al., pp. 192-197.
[24] Duke Energy Carolinas and Duke Energy Progress Response to NC Public Staff Data Request 10-3.

resource procurement and price discovery. These prices may be supplemented as needed by NREL ATB and EIA AEO for the purposes of further Carbon Plan modeling and analysis.

C. Differences in Synapse and Duke's Fuel Price Forecasts Show Inherent Commodity Price Risk Associated with Gas-Fired Resources.

Q. BRIEFLY SUMMARIZE DUKE'S METHODOLOGY FOR DEVELOPING GAS PRICE FORECASTS AND COMPARE IT TO SYNAPSE'S METHODOLOGY.

A. Duke relies on near-term gas market futures prices from NYMEX and a long-term fundamental forecast based on an average of the 2021 EIA Annual Energy Outlook and proprietary sources, including forecasts from Wood Mackenzie and IHS, and also blends projected costs of hydrogen into its price forecast.

Synapse used a forecasting methodology similar to Duke's, with the following revisions:

(i) Synapse relied on a more recent (June 2022) set of NYMEX futures prices;

(ii) Synapse used the more recent 2022 AEO instead of the 2021 AEO, and exclusively relied on the 2022 AEO instead of averaging the AEO with proprietary sources.

Q. DESCRIBE HOW THE SYNAPSE AND DUKE GAS PRICE FORECASTS DIFFER.

A. Figure 5, below, compares the short-term gas price forecasts developed based on the Synapse and Duke methodologies.

[BEGIN CONFIDENTIAL]

[redacted]

[redacted]

[END CONFIDENTIAL]

In the short term, Synapse and Duke's gas price forecasts sharply diverge. Synapse's use of more current data reflects the impact of recent global events on gas commodity prices.

Q. WHAT IMPACT DO GAS PRICE FORECASTS HAVE ON THE RESOURCES SELECTED IN EACH PORTFOLIO AND THE COST OF EACH PORTFOLIO?

A. Lower gas prices will result in lower total production costs. Use of a lower gas price will signal to the EnCompass model that a gas plant is relatively less expensive to operate, which will drive the model to select more gas plants. Gas plants are generally less capital-intensive than renewable projects but have large operating costs, composed mostly of fuel costs, which are passed directly to customers through the fuel rider. Therefore, relying on low gas prices deflates one of the main components of the net present value of revenue requirements for gas resources. This will both (1) drive the model to build more gas plants than is economically optimal and (2) understate the likely costs associated with operating and maintaining gas plants.

Q. WHY IS IT CONCERNING THAT DUKE'S FORECAST IS SO MUCH LOWER THAN SYNAPSE'S GAS PRICE FORECAST?

A. Synapse's gas price forecast better reflects the influence of recent market factors and geopolitical events. Gas prices are inherently tied to commodity pricing dynamics, and North Carolina ratepayers' exposure to commodity price risk is directly related to the magnitude of dependence on gas fuel in Duke's portfolio. Several other intervenors shared this concern with Duke's price forecast, especially in light of recent global events that have driven up gas prices, including the Public Staff[25] and the AGO.[26]

D. Regional Wind Power Purchase Agreements Drive Substantial, Zero-Carbon Savings for Ratepayers.

Q. DID THE *CARBON-FREE BY 2050* SCENARIOS INCLUDE CONSIDERATION OF ANY RESOURCES OUTSIDE THE CAROLINAS?

A. Yes. The *Carbon-Free by 2050* report includes a *Regional Resources* scenario that allows the model to select onshore wind power purchase agreements ("PPAs") from the Midcontinent Independent System Operator ("MISO") region, transferred to Duke's territory through PJM.[27] Duke

[25] Public Staff Report, pp. 70-74.
[26] AGO Strategen Report, pp. 23-4.
[27] The *Carbon-Free by 2050* report includes additional details on modeling Midwest wind resources in Appendix A on page A-13.

criticized this assumption, claiming that the costs and transmission needs are too high to make this a feasible option.[28] In our analysis, however, even including the firm PJM border rate for these imports, EnCompass still found these PPAs to be cost-effective. Future carbon and transmission planning should draw on the North Carolina Transmission Planning Collaborative's 2021 Public Policy Study to inform transmission investments necessary to bring in low-cost Midwest wind resources.[29]

Q. HOW DOES THE AVAILABILITY OF MIDWEST WIND PPAS IN THE *REGIONAL RESOURCES* PORTFOLIO AFFECT ITS COST RELATIVE TO THE OTHER PORTFOLIOS IN THE *CARBON-FREE BY 2050* REPORT?

A. Table 3, below shows the differences in total cost for each scenario assessed in the *Carbon Free By 2050* report.

Table 2. Net Present Value Revenue Requirement, by Scenario

Results (2022-2050)	*Duke Resources*	*Optimized*	*Regional Resources*
2030 NPVRR ($B)	$36.7	$36.0	$34.3
2040 NPVRR ($B)	$77.7	$69.8	$65.8
2050 NPVRR ($B)	$121.2	$103.5	$98.1

Compared to the *Optimized* scenario, the *Regional Resources* scenario achieves incremental savings of $1.7 billion by 2030 and $5.4 billion by 2050.

Q. BASED ON THIS FINDING, WHAT IS YOUR RECOMMENDATIONS TO THE COMMISSION?

[28] Direct Testimony of Roberts and Farver, Duke Energy Carolinas and Duke Energy Progress, pp. 59-61.
[29] *See*: *Carbon-Free by 2050* report, p. 14.

A. When zero-carbon resources from outside the Carolinas are made available for selection by the model, they can provide significant cost savings to North Carolina ratepayers, on the order of billions of dollars. The Tech Customers make a similar point in their report.[30] Given that the Carbon Plan will be designed to identify the least-cost pathway to meet carbon requirements, and that regional resources have the potential to "shrink the challenge" of reducing carbon by cost-effectively reducing net load in the Carolinas, the Commission should consider these resources. I recommend that the Commission consider both firm and non-firm power purchase agreements of zero-carbon power from outside the Carolinas in developing the Carbon Plan and directing further modeling.

E. The Carbon Plan Should Consider a Range of Transmission Options to Identify Least-Cost Resource Pathways.

Q. BRIEFLY DESCRIBE TRANSMISSION ASSUMPTIONS DUKE RELIED ON IN MODELING ITS CARBON PLAN.

A. Duke's EnCompass database, which forms the foundation for each of its proposed scenarios, includes the following embedded assumptions about regional transmission and coordination from 2022 to 2050:

1. Transmission capacity between DEC and DEP is constant over the 2022-2050 planning period, with no option to expand capacity;
2. DEC and DEP are maintained as separate balancing authorities over the 2022-2050 planning period;
3. Neither DEC nor DEP is allowed to purchase or sell energy or capacity from neighboring regions over the 2022-2050 planning period;

[30] Tech Customer Gabel Report, p. 8.

4. As a result, inter-regional transmission is not modeled, and any economic improvements resulting from inter-regional transmission are not incorporated into the analysis;

5. Neither DEC nor DEP is allowed to procure resources from outside of their service areas, with the exception of onshore wind in PJM for DEC;

6. The level of capacity assistance from neighbors (for purposes of calculating planning reserve margin) is expected to be constant over the planning period; and

7. No regionalization entities or institutions, such as energy imbalance markets or regional transmission organizations, are modeled over the planning period.

The only exception to the above is the inclusion of a "Future purchase" resource in each portfolio that allows Duke Energy to economically purchase zero-carbon power in the final years of each planning portfolio.[31]

Q. WHAT ARE THE IMPLICATIONS OF THESE EMBEDDED ASSUMPTIONS ON THE PORTFOLIOS PRODUCED BY DUKE?

A. Duke's reliance on a static transmission configuration in its EnCompass modeling, and its decision not to evaluate transmission sensitivities or alternatives, means that the Companies did not assess the cost, reliability, operational, or carbon impacts of any of the potential transmission developments enumerated above. By omitting consideration of these transmission options, Duke's proposed carbon plan filing artificially constrains the resource pathways and solutions available to meet HB 951 requirements.

[31] Duke Energy (2022). Carolinas Carbon Plan Modeling Analysis Overview. Docket No. E-100 Sub 179.

Q. IS THIS APPROACH CONSISTENT WITH LEAST-COST RESOURCE PLANNING?

A. No, especially in the context of long-term decarbonization planning. High-quality studies of power sector decarbonization consistently underscore the critical role of transmission in bolstering resource adequacy and enabling delivery of high-quality solar and wind resources to serve load.[32] The Tech Customers share our concerns with Duke's static approach, stating that "Duke did not engage in a holistic portfolio and scenario-based planning process or optimize its transmission strategy to address public policy and reliability needs. Instead, each transmission and interconnection investment category was developed piecemeal and integrated into Duke's proposed carbon plan."[33]

Duke tacitly acknowledges the problems with such an approach by including "Future Purchase" resources, which come from outside the region, in its portfolios in the final years of its carbon plan. This reflects the critical role that regional transactions can play in reliably and cost-effectively operating a low- and zero-carbon grid.

Q. BASED ON THIS FINDING, WHAT IS YOUR RECOMMENDATION TO THE COMMISSION?

A. The Commission should ensure that carbon planning includes consideration of all reasonable transmission and regional coordination

[32] *See:* Princeton Net Zero America study (2020); MIT Value of Inter-regional Coordination study (2021); Electric Power Research Institute Powering Decarbonization: Strategies for Net-Zero CO2 emissions (2021); and NREL Seams Study (2017).

[33] Tech Customers Gabel report, p. 15.

options that could be part of a least-cost plan for ratepayers. To the extent that the Commission deems that a distinct process from integrated resource planning is required (and that the existing public policy request function of the North Carolina Transmission Planning Collaborative is unable to fulfill this role), the Commission should initiate a new proceeding for pursuing long-term, prospective regional transmission planning and consideration of regional coordination. In any case, consideration of options in this proceeding should include a wide set of transmission and coordination alternatives, rather than being constrained by a single set of assumptions embedded in the EnCompass model.

F. Long-Term Planning Should Avoid Path Dependence and Lock-In Risks.

Q. BRIEFLY INTRODUCE THE CONCEPT OF PATH DEPENDENCE AS IT RELATES TO RESOURCE PLANNING.

A. Path dependence is a concept where past events constrain the set of solutions or decisions that are available in the future.[34] A similar term, "lock-in," describes previous events or decisions that commit an entity to future actions based on a past decision.

Given the multi-decade lifetimes of most generation resources, path dependence is a consistent feature of electricity resource planning. Historically, alternative generation options were not competitive, and load

[34] Liebowitz, S., & Margolis, S. (1995, April). Path Dependence, Lock-In, and History. *Journal of Law, Economics, and Organization, pp. 205-226.* Retrieved at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1706450.

and consumer growth were relatively consistent.[35] But with renewable and storage costs falling, slow load growth and electrification adding uncertainty to load forecasts, and states and utilities adopting decarbonization trajectories, path dependence presents an increasing risk to ratepayers and to compliance with carbon reduction requirements. For example, near-term investments in carbon-emitting resources can preclude the ability to invest in cost-effective renewable resources. Investments in long-lived fossil infrastructure can also lock a power system into a certain level of carbon emissions for the lifetime of the resource, called "committed emissions."[36]

To avoid risks arising from path dependence and lock-in, utilities should prioritize least-regrets resource decisions in the short term, while minimizing or deferring decisions that would commit the utility to a given pathway in the face of uncertain planning constructs, policies, and costs.[37]

Q. HOW DOES CAPACITY EXPANSION MODELING ASSESS THE RISK ASSOCIATED WITH LOCKING IN SPECIFIC RESOURCES, SPECIFICALLY FOSSIL RESOURCES?

A. There is no single model output that can indicate the level of path dependence of one portfolio versus another. The best way to assess the

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[35] Weston, F. (2009, May). Integrated Resource Planning: History and Principles. *The Regulatory Assistance Project.* Retrieved at: https://www.raponline.org/wp-content/uploads/2016/05/rap-weston-integratedresourceplanningoverview-2009-05-20.pdf.

[36] Shearer, C., Tong, D., Fofrich, R., Davis, S. (2020, September). Committed Emissions of the U.S. Power Sector, 2000-2018. AGU Advances. Retrieved at: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2020AV000162.

[37] *See:* Northern States Power Company (2020). Upper Midwest Integrated Resource Plan, 2020-2034. p. 90. Retrieved at: https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/The-Resource-Plan-No-Appendices.pdf.

lock-in risk of a portfolio or a resource is to run sensitivities—that is, to see how it performs when you change a series of key inputs and assumptions (for example, higher or lower gas prices, the cost of alternatives) and then assess the results. If, for example, the decision to lock in a resource is favorable under only a narrow set of conditions and will incur high costs for ratepayers under many other likely conditions, then there is a high risk associated with locking in that resource. On the flip side, if a resource is found to perform well under a wide range of assumptions, then it is less likely to lock ratepayers into otherwise avoidable costs.

Q. DESCRIBE ANY PATH DEPENDENCE RISKS THAT YOU HAVE IDENTIFIED IN DUKE'S PROPOSED CARBON PLAN ENCOMPASS ANALYSIS AND FILING.

A. I observe the following path dependence risk factors in Duke's proposed carbon plan filing:

1. **Delay in projected achievement of HB 951's 70 percent carbon reduction requirement.** Several portfolios in Duke's carbon plan filing delay meeting HB 951's carbon reduction requirement, doing so in 2032 or 2034 instead of 2030. This reduces flexibility if unforeseen delays occur and increases the risk of noncompliance with HB 951's carbon reduction requirements.

2. **Short planning horizon.** Duke divided the planning horizon in its EnCompass modeling into a series of 8-year segments and a final 5-year segment (i.e., 2022-2029, 2030-2037, 2038-2045, and 2046-

2050),[38] Given the multi-decade transition contemplated in this proceeding, an eight-year horizon is a short-term approach that will not integrate long-term planning dynamics, including carbon reduction requirements.

3. **Continued investment in gas plants.** Duke plans to continue investing in gas plants, on the assumptions that (1) low-cost Appalachian gas will be available to supply existing and new combined-cycle plants ("CCs"); and (2) it will be economic in the future to convert and operate combustion turbines on hydrogen. But both are high risk assumptions: The first assumption carries risk because the pipeline necessary to supply Appalachian gas is not yet completed.[39] Without the completed pipeline, Duke may not have access to sufficient firm gas capacity to fuel its CCs, as the AGO notes in the Strategen report.[40] The second assumption is risky because it presumes that retrofits will be technically feasible and cost-effective and requires hydrogen to be available at the price and quantity needed to compete with other fuels. In the event that technical issues prevent cost-effective turbine conversion or a sufficient supply of zero-carbon hydrogen is not available, existing and planned gas plants risk becoming obsolete, and the burden of paying off these stranded

[38] Pages B-15 and B-16 of Appendix B of the *Carbon-Free by 2050* report contain more information on Duke Energy and Synapse EnCompass planning horizons.
[39] Snider et al., p. 178.
[40] AGO Strategen Report, p. 26.

assets will fall on either shareholders or Duke ratepayers. Other intervenors expressed concern about the risks of Duke planning its system around hydrogen, including the Public Staff[41] and the AGO.[42]

4. **Concurrent construction of non-commercial nuclear technologies.** Duke's proposed portfolios include up to 21 new advanced and small modular nuclear reactors to be built between 2033 and 2050. This schedule would require, on average, construction of just over one new unit per year and would entail concurrent construction on multiple units before the first unit has successfully achieved operation.[43] Concurrent development of these uncertain, not-yet-commercialized resources could lock in additional costs for ratepayers in the event of cost over-runs or operational problems. Synapse is not alone in its concerns around small modular nuclear reactors: the Tech Customers also express similar concerns around locking customers in to speculative technologies.[44]

Q. BRIEFLY DESCRIBE HOW THE *CARBON-FREE BY 2050* SCENARIOS AVOID PATH DEPENDENCY RISKS.

A. The *Carbon-Free by 2050* EnCompass analysis employs the following inputs and parameters to avoid path dependency risks:

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[41] Comments of the Public Staff ("Comments of the Public Staff") (2022, July). North Carolina Utilities Commission. Docket No. E-100, Sub 179, pp. 95-96.
[42] AGO Strategen Report, p. 30.
[43] Pages A-11 and A-12 of Appendix A of the *Carbon-Free by 2050* report contain additional discussion of Duke Energy's nuclear availability settings.
[44] Tech Customer Gabel, p. 58.

5. **2030 achievement date for 70 percent reduction requirement.** This approach maintains the HB 951's default deadline for achievement of the 70 percent carbon reduction and allows for flexibility in later planning proceedings in the event that the Commission determines that a delay is warranted.

6. **15-year planning horizon.** Synapse's EnCompass analysis uses a 15-year planning horizon, which strikes an appropriate balance between computational complexity and integrating long-run portfolio requirements, such as carbon reduction requirements.

7. **Adjusted lifetime and hydrogen assumptions for gas-fired resources.** EnCompass analysis in the *Carbon-Free by 2050* report allows existing gas units to be retired if it is more economic to do so, rather than be converted to 100 percent hydrogen combustion. Newly constructed gas-fired resources are assumed to have an operating life of 25 years and a depreciation lifetime of 20 years in order to avoid stranded asset risk as carbon requirements decline toward zero by 2050.

8. **National reference cost and less ambitious deployment timeline for non-commercial nuclear technologies.** The *Carbon-Free by 2050* report uses national reference costs and anticipates a less ambitious deployment timeline for new nuclear resources to maintain a conservative approach to cost assumptions for projects with a high amount of uncertainty, allow for learning by doing, and avoid lock-in.

Q. AFTER ACCOUNTING FOR PATH DEPENDENCE RISKS, WHAT SELECTIONS DID ENCOMPASS ECONOMIC OPTIMIZATION MAKE IN THE *CARBON-FREE BY 2050* PORTFOLIOS?

A. In the scenarios where EnCompass was allowed to economically optimize resources in the *Carbon-Free by 2050* report, the model did not select any additional gas-fired resources and opted for the retirement of some gas-fired units, rather than conversion to 100 percent hydrogen combustion.[45] The *Regional Resources* scenario did not reach the 4-unit availability limit set for additional nuclear resources.[46]

Q. BRIEFLY SUMMARIZE DUKE'S DISCUSSION OF "OUTCOME-ORIENTED ASSUMPTIONS" AND PROVIDE YOUR RESPONSE.

A. Duke Energy witnesses Snider et al. claim several times in testimony that certain inputs to the *Carbon-Free by 2050* analysis are "outcome-oriented."[47] In a sense, this description is correct: The assumptions developed for the *Carbon-Free by 2050* analysis are designed to approximate present and projected future conditions, with the intended outcome of producing a portfolio that provides cost-effective, reliable power for North Carolina ratepayers while meeting HB 951's carbon-reduction requirements. This is the outcome that resource planning is designed to produce, and, while Duke witnesses may disagree with the empirical or analytical justification for these assumptions, the implication that the

[45] See Section 3 of the *Carbon-Free by 2050* report.
[46] See Page C-3 of the *Carbon-Free by 2050* report, Appendix C.
[47] Snider et al., p. 185-195.

Carbon-Free by 2050 assumptions are intended to produce something other than cost-effective, reliable, and sustainable power is not accurate.

As an example, the *Carbon-Free by 2050* assumption of a 25-year operating lifetime and 20-year depreciation lifetime for gas-fired resources is not intended to produce a specific resource outcome, but instead is based on basic risk management principles. Carbon emissions associated with these resources are regulated by HB 951, which requires that emissions reach zero by 2050. If the technology and infrastructure to decarbonize these resources (i.e., zero-carbon hydrogen supply and transport) does not develop as contemplated in Duke Energy's carbon plan filing, these conservative lifetime assumptions minimize stranded asset risk for Duke and its ratepayers.

Q. WHAT IS YOUR RECOMMENDATION TO THE COMMISSION RELATED TO PATH DEPENDENCE?

A. Given the potential negative impacts of path dependence in the context of the Carbon Plan and the numerous risks arising from path dependence in Duke's proposal, the Commission should incorporate several revisions into future Carbon Plan modeling to reduce the risks associated with high path dependence. These include:

1. Lengthening the optimization horizon for capacity expansion analysis;
2. Maintaining a 2030 achievement date for achieving the 70 percent carbon reduction requirement, and applying reasonable lifetime assumptions to new-construction gas-fired units;

3. Placing stringent limits on the assumed supply of zero-carbon hydrogen and the technical and cost feasibility of hydrogen retrofits; and
4. Maintaining conservative cost and availability assumptions for new nuclear units.

G. Duke's Supplemental P5 and P6 Portfolios Do Not Adequately Address Modeling Issues Associated with Duke's Proposed Portfolios.

Q. HAVE YOU REVIEWED THE P5 AND P6 PORTFOLIOS THAT DUKE DESCRIBED IN ITS FILING TO THE COMMISSION ON JULY 28,[48] THE RESULTS OF WHICH WERE INCLUDED IN DUKE'S AUGUST 19 TESTIMONY?

A. Given the importance of an in-depth understanding of modeling results and the short time period for intervenors to review the P5 and P6 results, I did not perform a detailed review of the process of modeling those scenarios or of the resulting portfolios for this testimony. However, I did review the revisions to model inputs for the P5 and P6 scenarios.

Q. DO THESE REVISIONS CORRECT THE MODELING ISSUES IDENTIFIED IN THIS TESTIMONY AND THE *CARBON-FREE BY 2050* REPORT?

A. No. Table 4, below, shows issues that were improved or not improved by selected P5 and P6 revisions to model inputs.

[48] Duke Energy filing Re: Development of Supplemental Modeling Portfolios, Docket No. E-100 Sub 179. Retrieved at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=c60326e0-4390-46ef-9b92-0face09a187b.

Table 3. Evaluation of Selected Changes Present in Duke Energy Supplemental Portfolios 5 and 6

#	Model Change	Improvement to Carbon Plan modeling?	Explanation / Comments
1	Delay of HB 951 compliance date	No	Delay of HB 951 compliance date exacerbates risk of non-compliance
3	Dynamic dispatch of solar plus storage	Yes	More precise simulation of solar plus storage capabilities; IRA may impact battery charging requirements
4	Remove cumulative limits on 4- and 6-hour batteries	Yes	Deployment limits distort final results
5	Remove H_2 blending with gas	Yes	Insufficient support for sufficient zero-carbon hydrogen; Duke Energy's offset and hydrogen-fueled combustion turbine approach is not appropriate
6	Model solar as PPA for 45%	Yes	More precise estimate of solar costs
7	Low energy efficiency case	No	Higher level of energy efficiency is achievable and lowers total system cost
8	Remove access to Appalachian gas	Yes	Better reflects real-world conditions
13	Validate selection of gas plants through a full-period capacity expansion optimization	Yes	Still necessary, even with changes to hydrogen treatment

Q. PROVIDE ADDITIONAL COMMENTS ON ITEM 3 ("DYNAMIC DISPATCH OF SOLAR PLUS STORAGE") FROM THE TABLE ABOVE.

A. I generally agree with the Public Staff's finding that Duke's fixed-dispatch treatment of solar plus storage resources is an imprecise method for modeling the contribution of these resources, and that dynamic dispatch would provide additional insight.[49] While I relied on Duke's fixed solar-plus-storage dispatch curves in the *Carbon-Free by 2050* report for consistency with Duke's method, I support the Public Staff's recommendation to model dynamic dispatch for these resources.

I also agree with Public Staff's perspective that storage resources deployed in a solar-plus-storage configuration should have the capability of charging directly from the grid.[50] Changes to clean energy tax credits resulting from the IRA will further ease configuration requirements and further support grid charging.

Q. PROVIDE ADDITIONAL COMMENTS ON ITEM 5 ("REMOVE H_2 BLENDING WITH GAS") FROM THE TABLE ABOVE.

A. While I think it is appropriate to apply a skeptical eye toward hydrogen supply assumptions, Duke's implementation of this revision is contradictory. Duke's proposed implementation details for Item 5 indicate, for example, that hydrogen turbines would be removed as an option, but that combustion turbines built after 2040 could operate on 100 percent

[49] Comments of the Public Staff, Duke Energy Progress, LLC and Duke Energy Carolinas, LLC 2022 Carbon Plan, Docket No. E-100, Sub 179. July 16, 2022. P. 119-126.
[50] Comments of the Public Staff, pp. 123-124.

hydrogen.[51] These assumptions apply conflicting expectations of hydrogen availability and therefore have limited analytical value. I recommend that, in addition to a scenario without any zero-carbon hydrogen availability, the Commission direct modeling of a hydrogen scenario with very low availability (maximum 5 percent capacity factor for all hydrogen-fueled units), no option for hydrogen conversion, and conservative hydrogen cost assumptions.

Duke also discusses a different treatment of carbon emissions in its implementation details for Item 5 that is not aligned with resource planning best practices. The availability and price of carbon offsets in 2050 is uncertain, and these costs should be included alongside other relevant costs for economic optimization. I recommend that any further modeling not assume any supply of carbon offsets in the portfolio's final years. To the extent that the model is allowed to select carbon offsets, the model should include multiple price levels, including a high offset level of $250 per ton or greater, and they should be integrated into economic optimization.

Q. PROVIDE ADDITIONAL COMMENTS ON ITEM 7 ("LOW ENERGY EFFICIENCY CASE") FROM THE TABLE ABOVE.

A. As discussed previously, and as explained in detail in the *Carbon-Free by 2050* report, energy efficiency is a cost-effective resource for Duke ratepayers, and Duke should expand, rather than reduce, the impact of

[51] Duke Energy filing Re: Development of Supplemental Modeling Portfolios, Docket No. E-100 Sub 179. Retrieved at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=c60326e0-4390-46ef-9b92-0face09a187b.

energy efficiency. I also recommend that the Commission decline to use the low EE case for planning purposes.

Q. PROVIDE ADDITIONAL COMMENTS ON ITEM 13 ("VALIDATE SELECTION OF GAS PLANTS THROUGH A FULL-PERIOD CAPACITY EXPANSION OPTIMIZATION") FROM THE TABLE ABOVE.

A. I do not agree with Duke's statement that its treatment of hydrogen fuel renders full-period optimization capacity expansion unnecessary. Even without hydrogen conversion, carbon requirements are expected to put pressure on gas resources to lower emissions rates, which will drive down capacity factors over time. Resources with lower utilization and higher costs are less attractive in an economic optimization and will be less likely to be selected by the EnCompass model. With a short optimization period, the model may not see the falling utilization and rising costs as it makes its near-term resource planning decisions. I therefore recommend that the Commission direct the Company to include a full-period capacity expansion optimization.

Q. BASED ON YOUR REVIEW OF PROPOSED PORTFOLIOS P5 AND P6, DO YOU HAVE A RECOMMENDATION TO THE COMMISSION?

A. I recommend that further modeling directed by the Commission implement items number 4, 6, and 8 in Table 4, above. Additionally, I make the following recommendations to the Commission on developing its Carbon Plan and further Carbon Plan modeling:

1. Allow storage deployed alongside solar to charge directly from the grid;

2. In scenarios that include carbon offsets or allowance costs, they should be modeled at multiple price levels and included as a relevant cost in capacity expansion optimization; and
3. Include a full-period capacity expansion optimization.

H. The 2022 Carbon Plan Modeling Process Did Not Facilitate Shared Understanding or Collaboration Across Stakeholders.

Q. WHAT ARE THE BENEFITS OF COLLABORATIVE MODELING AND ANALYSIS IN RESOURCE PLANNING PROCEEDINGS?

A. Collaborative modeling can build a shared analytical foundation (i.e., understanding of the modeling tools) for evaluating future resource needs and potential resources available to meet those needs. When multiple parties share this analytical foundation, they can craft robust solutions together and find areas of agreement. Collaborative problem solving, however, requires a commitment to sharing lessons learned and findings, maintaining transparency and problem-solving on the part of all participants.

Modeling tools that are common across stakeholders (such as EnCompass in this proceeding) are valuable assets for collaboration and problem-solving because they facilitate organization and sharing of vast amounts of information and clarify the analytical approach to many of the thorny issues present in resource planning. With the support of a well-defined and resourced collaboration process, EnCompass could form the backbone of effective collaboration and shared problem-solving.

Q. PLEASE IDENTIFY ANY BARRIERS TO EFFECTIVE COLLABORATION YOU OBSERVED IN THE COURSE OF YOUR WORK IN THIS PROCEEDING.

A. The Synapse team encountered several barriers in its review and analysis of the EnCompass database shared by Duke in this proceeding.[52] These barriers included the following:

1. The data files were not properly transferred to intervenors by Duke, which caused initial model runs to fail and delayed the start of our modeling analysis.
2. There were inconsistencies between database inputs and provided outputs that led to substantial delays in EnCompass modeling and prevented intervenors from validating Duke's results;[53]
3. Key data inputs were functionally impossible to parse without additional input spreadsheets from Duke, which were only provided through discovery; and
4. Duke conducted additional modeling steps outside of EnCompass. Other parties were not able to reproduce this analysis without additional licensed software (for which Synapse did not have a license) and Duke did not provide a detailed explanation of how the analysis was conducted.

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[52] These barriers are discussed in detail in Appendix B of the *Carbon-Free by 2050* report.

[53] Duke Energy (2022, June). EnCompass Input Data: Declining Cost Adder Issue and Resolution. Docket No. E-100 Sub 179.

Q. ARE YOU AWARE OF ANY OTHER PARTIES THAT ENCOUNTERED ISSUES WITH DUKE'S ENCOMPASS DATABASE?

A. Yes. The Public Staff described encountering similar issues in their comments to the Commission in this proceeding.[54] These issues ultimately prevented the Public Staff from submitting its own proposed carbon plan in this proceeding.

Q. ARE YOU AWARE OF OTHER PROCEEDINGS WHERE ENCOMPASS COLLABORATION AND VALIDATION HAS OCCURRED SUCCESSFULLY?

A. Yes. It is my understanding that utilities and stakeholders successfully shared and validated resource planning model data in proceedings with Xcel in Colorado, Xcel in Minnesota, and Duke Energy in Indiana.

Q. PROVIDE YOUR RECOMMENDATIONS TO THE COMMISSION ON FACILITATING MORE EFFECTIVE COLLABORATION IN FUTURE CARBON PLAN AND RESOURCE PLANNING MODELING PROCESSES.

A. I provide the following recommendations:

1. **Longer collaboration process, including sharing of all data during plan development.** Model review, sharing, and validation is an effort- and time-intensive undertaking, and the results of this proceeding show how just a few validation issues can seriously impact stakeholders' ability to provide additional insight to the Commission. EnCompass collaboration should include the sharing of contemporary model data at the outset of the process and occur over a longer

[54] Comments of the Public Staff. p. 36-37.

timescale. This would allow parties to have substantive conversations about model inputs and methodology and avoid validation issues.

2. **Higher transparency for model inputs.** For model inputs that are not transparently derived from public sources, the utility should provide the derivation of these inputs proactively, rather than through the discovery process.

3. **Transparency for out-of-model resource planning steps.** To the extent that the Commission finds the use of out-of-model planning steps appropriate, the utility should take all necessary steps to render the inputs, methodology, and outputs of those steps transparent for collaborators.

IV. Issues related to "Coal Unit Retirement Schedule"

I. Duke Energy's Coal Retirement Methodology Delayed Coal Retirement Dates Without Adequate Justification and at a Cost to Ratepayers.

Q. BRIEFLY SUMMARIZE DUKE'S COAL RETIREMENT METHODOLOGY AS IMPLEMENTED IN ITS PROPOSED CARBON PLAN FILING.

A. In developing its proposed carbon plan, Duke used a multi-step process for selecting coal unit retirement dates. First, it conducted capacity expansion runs with fixed retirement dates to establish projected capital investments and operations and maintenance costs for each unit. It used those cost projections in a run that allowed EnCompass to economically retire its coal units. After EnCompass selected the most economic retirement dates for the coal fleet, Duke manually delayed the retirement year for several of its coal units.[55] Table 5, below, shows the economic retirement year identified by Duke's EnCompass run and the retirement year proposed by Duke for each of its coal units.

Table 4. Duke Coal Units, Modeled and Proposed Retirement Dates

Unit	Super- or Sub-Critical	Construction Year	Winter Capacity (MW)	Economic Retirement Year	Proposed Retirement Year
Belews Creek 1	Super	1974	1,110	2030	2036
Belews Creek 2	Super	1974	1,110	2030	2036
Cliffside 5	Sub	1972	546	2026	2026
Marshall 1	Sub	1965	380	2026	2029
Marshall 2	Sub	1966	380	2026	2029
Marshall 3	Super	1969	658	2034	2033
Marshall 4	Super	1970	660	2034	2033
Mayo 1	Sub	1983	713	2026	2029
Roxboro 1	Sub	1966	380	2029	2029
Roxboro 2	Sub	1966	673	2029	2029
Roxboro 3	Sub	1973	689	2030	2028-2034
Roxboro 4	Sub	1980	711	2030	2028-2034

Source: Carbon-Free by 2050, Appendix D. Proposed retirement dates are from Duke Energy Portfolio 1.[56]

Q. IS THIS METHODOLOGY CONSISTENT WITH LEAST-COST RESOURCE PLANNING?

A. No. When EnCompass retires any existing unit, it does so because the energy and capacity provided by that unit could more economically be provided by other resources. Stated another way, the costs to operate the unit exceed the value of the energy and capacity it provides. In short, EnCompass identified coal units for retirement on the schedule it did

[55] Pages 28-29 of the *Carbon-Free by 2050* report contain a summary of Duke Energy's coal retirement methodology.

[56] Although the information in Table 5 was derived in part from confidential data, counsel for Duke Energy confirmed that Table 5 could be presented in the public, unredacted version of this testimony.

because continuing to operate them was more expensive for ratepayers than retiring them. The manual delays implemented by Duke keep these units online, at ratepayers' expense. Moreover, in almost all cases Duke's proposed retirement dates are years later than the "Earliest Practicable" retirement years identified in the Companies' 2020 IRPs.[57] Maintaining these units past their economic retirement dates could cost Duke ratepayers $1.4 billion, before accounting for fuel costs, variable operations & maintenance costs, or lost securitization benefits.[58] Duke challenges our estimates of the costs required to sustain its coal plants, stating that my analysis overstates the costs by $1 billion.[59] But Duke has not justified its low cost assumptions, which could be proven wrong in the future. If actual future fixed operations and maintenance plus ongoing capital costs exceed Duke's projections, ratepayers could end up shouldering the cost premium, absent a disallowance. My use of a projection based on actual incurred costs, rather than a hypothetical schedule with no built-in accountability mechanism, provides a reasonable and transparent basis for estimating these costs.

Q. DUKE ASSERTS THAT THE MANUAL DELAYS TO COAL RETIREMENTS WERE NECESSARY TO MAINTAIN RELIABILITY. HOW DO YOU RESPOND?

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[57] *See:* Duke Energy Carolinas Integrated Resource Plan 2020 Biennial Report, p. 175; and Duke Energy Progress Integrated Resource Plan 2020 Biennial Report, p. 174.
[58] *Carbon-Free by 2050*, p. 29.
[59] Snider et al., pp 141-143.

A. There may be power supply and reliability concerns with retiring coal capacity, which may require the development of replacement generation and transmission resources to provide the same energy, capacity, and ancillary services previously provided by the retiring coal units. Modeling specific power flow requirements is not a suitable task for a resource planning tool like EnCompass, and is better understood through power flow modeling and approximated in EnCompass using earliest possible retirement dates. The "Earliest Practicable" retirement dates developed at the direction of the Commission for the Companies' 2020 IRPs were designed to accommodate construction of replacement resources. Almost all of Duke's manual adjustments in this case extend for years beyond those "Earliest Practicable" dates, however, without sufficient justification for why these extensions are necessary.

Duke witnesses Roberts and Farver contend that Duke Energy's justifications for the manual delays are sufficiently detailed, but their discussion of specific unit retirements continues to rely on high-level assumptions rather than detailed requirements and timelines.[60] For example, witnesses Roberts and Farver repeat Duke's assertion in its proposed carbon plan that "Belews Creek units will continue to operate into the 2030s" and state that Duke has not yet evaluated requirements for retirement of these units: "DEC plans to evaluate transmission upgrades to

[60] Testimony of Duke Energy Witnesses Roberts and Farver, Docket No. E-100 Sub 179 ("Roberts and Farver"), p. 52-55.p

enable retirements as the planned retirement approaches."[61] This approach is opposed to the more appropriate approach of allowing EnCompass optimization to identify the most cost-effective retirement dates for these units.

Q. DESCRIBE ANY REVISIONS TO THE COAL UNIT RETIREMENT DATES YOU IMPLEMENTED IN THE *CARBON-FREE BY 2050* SCENARIOS.

A. In the *Optimized* and *Regional Resources* scenarios, Synapse allowed Duke's coal units to be retired at the economic date identified by EnCompass, with no additional delay to retirement.[62]

Q. HOW DID THESE REVISIONS IMPACT THE RESULTS OF THE *CARBON-FREE BY 2050 SCENARIOS?*

A. Table 6, below, shows the coal retirement dates selected by EnCompass in the *Optimized* and *Regional Resources* scenarios compared to the *Duke Resources* scenario.

Table 5. Retirement Year for Selected Coal Units by Scenario

Coal Unit	Capacity (MW)	Retirement Year		
		Duke Resources	*Optimized*	*Regional Resources*
Belews Creek 1-2	2,220	2036	2034	2030
Cliffside 5	546	2026	2023	2023
Marshall 1-2	760	2028	2026	2026
Marshall 3-4	1,318	2032	2032	2032
Mayo 1	713	2028	2028	2028
Roxboro 1-2	1,053	2028	2028	2028
Roxboro 3-4	1,400	2027	2027	2027

[61] Roberts and Farver, p. 53, ll. 14-16.
[62] *Carbon-Free by 2050*, pp. 12-13, 18-19.

Source: Carbon-Free by 2050, p. 17-18.

Even without building incremental gas combustion turbine or combined-cycle resources, we find that accelerating retirement of coal units compared to Duke's proposal is still in the best interest of ratepayers.[63]

Q. IS RELIABILITY MAINTAINED IN THE SYNAPSE SCENARIOS, EVEN WITH THE ACCELERATED RETIREMENT OF SOME UNITS COMPARED TO *DUKE RESOURCES*?

A. Yes. Even after implementing the retirements identified above, the *Optimized* and *Regional Resources* portfolios continue to meet reserve margin requirements every month and meet 100 percent load in all hours modeled in production cost modeling.

Q. WHAT IS YOUR RECOMMENDATION TO THE COMMISSION WITH REGARD TO COAL RETIREMENTS?

A. First, the Commission's Carbon Plan should adopt the economic retirement schedule identified by EnCompass rather than delayed retirement dates. For retirement years that the Companies claim are not operationally feasible, the Companies should provide compelling justification of the transmission and generation requirements, provide an explanation as to why procurement and development of alternative resources is not feasible in the given timeframe, and develop a proposed timeline for developing these resources and retiring these units as early as practicable.

Second, the Commission should direct the Companies to begin preparations for the retirement of coal units with economic retirement years

[63] *Carbon-Free by 2050,* pp. 18-19.

identified in the next six years. According to Duke's retirement analysis, these include Cliffside unit 5, Marshall units 1 and 2 and Mayo unit 1. For each of these units, Duke should specifically identify the transmission and generation requirements for retiring these units and make preparations for procuring and developing resources to address those requirements via all-source procurement.

Third, for the remaining coal units, the Companies should continue to use endogenous coal retirement analysis to assess the economic position of these units. The Commission should direct the Companies to develop specific generation or transmission resource requirements required for the retirement of these units to ensure expeditious retirement in the future.

V. <u>Issues related to "Near-Term procurement activity — solar, solar plus storage, standalone storage, onshore wind, natural gas generation"</u>

A. The Carbon-Free by 2050 Scenarios Provide a Roadmap to Near-Term Procurement in the Best Interest of Ratepayers.

Q. PROVIDE THE SHORT-TERM RECOMMENDATIONS THAT ARE INCLUDED IN THE *CARBON-FREE BY 2050* REPORT.

A. Table 9, below, presents recommendations to the Commission for short-term actions to reliably meet North Carolina's carbon reduction requirements at least cost.

Table 6. Carbon-Free by 2050 Short-Term Recommendations

RESOURCE	AMOUNT	PROPOSED NEAR-TERM ACTIONS
Proposed Resource Selections: In-Service through 2030		

Energy Efficiency	1.5 percent of retail load	• Expand utility energy efficiency savings targets to 1.5 percent of total retail load
Distributed Energy Resources	At least 1 GW by 2035	• Develop and support programs to empower customer-owned energy resources to accelerate contribution to grid needs
Additional Solar	7,200 MW	• Invest in transmission projects to unlock additional cost-effective solar power • Begin procurement of 4 GW of new solar 2022-2024 with target in-service dates of 2025-2028 • Develop interconnection methods that will be robust long-term
Battery Storage	5,600 MW	• Begin procurement for 4 GW of stand-alone storage with target in-service dates of 2025-2028 • Invest in operational capabilities for capitalizing on energy storage resources for grid services
Onshore Wind *(in-state)*	900 MW	• Engage with communities on onshore wind siting • Prepare for continued advancement of onshore wind, long-term
Onshore Wind *(Midwest)*	2,500 MW	• Engage in inter-regional coordination with PJM for facilitating power purchase • Integrate Midwest wind import into short-term transmission planning
Offshore Wind	800 MW	• Initiate development and permitting activities for 800 MW (or larger tranches if more cost-effective), with eye toward potential additional procurement long-term
Proposed Resource Selections: Options for Long-Term Cost-Effective Carbon Reductions		
Coal Retirement	--	• Develop retirement plans for coal units consistent with economic optimization
Transmission Planning	--	• Develop processes for long-term, prospective and regional transmission planning that can cost-effectively meet economic and carbon reduction requirements of HB 951
Pumped Storage Hydro	1,700 MW	• Conduct feasibility study, develop EPC strategy, and apply at FERC for re-licensing
Hydrogen Planning	--	• Develop more detailed hydrogen fuel cost planning methodology • Conduct studies of hydrogen transport, storage, and distribution • Integrate cost of production and distribution into resource planning

Source: Carbon-Free by 2050 report, p. 4-5.

I summarize the conclusions and recommendations of the *Carbon-Free by 2050* report on pages 4-5 and 43-45 of the *Carbon-Free by 2050* report.

B. The Inflation Reduction Act Underscores the Need for Near-Term Flexibility.

Q. ARE THERE ANY DEVELOPMENTS SINCE THE ISSUANCE OF THE *CARBON-FREE BY 2050* REPORT THAT MIGHT AFFECT LEAST-COST PLANNING TO MEET CARBON REQUIREMENTS?

A. Yes. The passage of the federal Inflation Reduction Act ("IRA") on August 16, 2022 has "major implications" for power generation in the United States,[64] and the IRA's tax incentive and electrification provisions would directly impact many of the factors that are used as inputs into capacity expansion analysis in this proceeding. A detailed review of the IRA is beyond the scope of this testimony, but based on my current understanding of the IRA's provisions and analyses of the impacts of the Act on the power sector,[65] I anticipate wide-ranging impacts on Carbon Plan analysis which are not fully incorporated into Duke's proposed carbon plan filing, the

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64 Proctor, D. (2022, August 12). "Renewable Energy, Electrification Big Winners in Inflation Reduction Act." *POWER Magazine.* Retrieved at: https://www.powermag.com/renewable-energy-electrification-big-winners-in-inflation-reduction-act/.

65 *See:* Mahajan, M., Ashmoree, O., Rissman, J., Orvis, R., & Gopal, A. (2022, August). Modeling the Inflation Reduction Act Using the Energy Policy Simulator. *Energy Innovation*. Retrieved by: https://energyinnovation.org/wp-content/uploads/2022/08/Modeling-the-Inflation-Reduction-Act-with-the-US-Energy-Policy-Simulator_August.pdf;
Jenkins, J., Mayfield, E., Farbes, J., Jones, R., Patankar, N., Xu, Q., & Schivley, G. (2022, August). Preliminary Report; The Climate and Energy Impacts of the Inflation Reduction Act of 2022. REPEAT Project, Princeton, NJ. Retrieved at: https://repeatproject.org/docs/REPEAT_IRA_Prelminary_Report_2022-08-04.pdf; and
King, B., Larsen, J., & Kolus, H. (2022, July). A Congressional Climate Breakthrough. *Rhodium Group.* Retrieved at: https://rhg.com/research/inflation-reduction-act/.

Carbon-Free by 2050 report, or initial comments by other parties in this proceeding.

Q. IN LIGHT OF THE INFLATION REDUCTION ACT, HOW SHOULD THE COMMISSION VIEW THE ANALYSES PRESENTED IN THIS PROCEEDING AND THE DEVELOPMENT OF ITS SHORT-TERM ACTION PLAN?

A. The need to incorporate impacts of recent events on integrated resource planning is not unique to the IRA or this proceeding; instead, it is an inevitable part of the resource planning and deliberation process. The scale of changes to the energy landscape in the IRA, however, warrants additional attention. As just one example, since the IRA lifts the offshore wind moratorium, Duke's restrictions on OSW based on the moratorium are no longer appropriate. In light of these changes, plans that maintain flexibility in the short term and that are likely to take advantage of cost-reductions facilitated by IRA provisions will be better able to adapt to changing circumstances.

Q. WHICH ACTIONS COULD THE COMMISSION DIRECT IN THE SHORT TERM THAT WOULD MAINTAIN FLEXIBILITY AND AVOID LOCK-IN?

A. I recommend that the Commission prioritize the following actions in their short-term execution plan:

1. **Invest in flexible, modular solar and storage resources.** Given their modular design, relatively quick construction times, and geographic flexibility, solar and storage resources represent flexible options with little risk of lock-in or path dependence. Large-scale deployment of solar, in particular, is a common feature of not only the *Carbon-Free by 2050* portfolios, but also the portfolios proposed by the Clean Power Suppliers' Association, Tech Customers and Duke. Further, the tax credits extended by the IRA have a ten-year eligibility

window; efforts made to maximize the value of these credits in the near term will benefit ratepayers.

2. Pursue actions that would expand resource options, including wind deployment capability, transmission planning, and coal retirement. These include continued development of capability for deploying on- and off-shore wind resources in the Carolinas and developing transmission planning processes that can unlock additional resource options.

3. Avoid investments in gas and nuclear resources that would commit North Carolina ratepayers to a specific resource pathway or set of actions in the future. Gas combustion turbine and combined-cycle resources lack the same modularity as solar and storage resources, and they commit the Carolinas to supporting these resources and managing additional carbon emissions for decades. Similarly, long construction timelines associated with new nuclear resources could lock in capital expenditure that would be more effective elsewhere.

VI. Issues Related to "EE / DSM / Grid Edge."

A. Savings from Expanded Demand-side Resources Benefit Ratepayers.

Q. BRIEFLY SUMMARIZE DUKE ENERGY'S APPROACH TO DEMAND-SIDE RESOURCES AND ENERGY EFFICIENCY IN ITS PROPOSED CARBON PLAN FILING.

A. Duke Energy modeled energy efficiency as a decrement to load based on two different forecasts of annual incremental savings. Specifically, the Company's "Base" energy efficiency forecast assumes incremental annual energy savings of one percent of Duke's retail load, net of load that has opted out of energy efficiency programs. The "High" forecast assumes savings equivalent to 1 percent of total retail load.[66] Figure 2, below, shows annual incremental savings targets for the "Base" and "High" forecasts used in developing Duke's portfolios.

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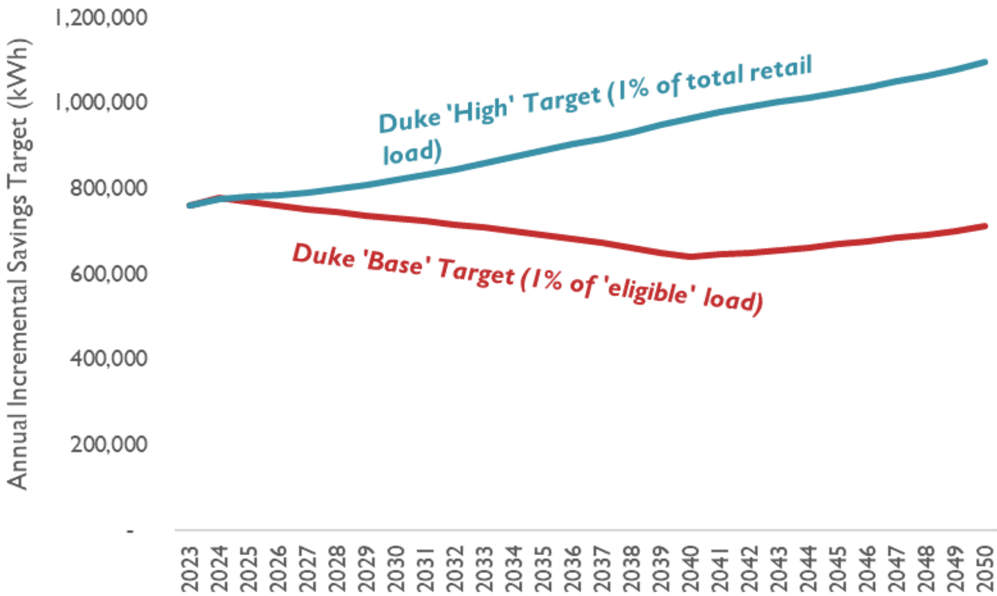
[66] Appendix E, p. 16.

Figure 5. Duke Energy Carolinas Annual Incremental Savings Target



Source: Derived from Duke Energy response to NC Public Staff Data Request 15-2.[67]

Notably, Duke Energy's base savings target anticipates a decrease in annual incremental energy efficiency savings over the long-term.

Q. ARE DUKE ENERGY'S ENERGY EFFICIENCY FORECASTS REASONABLE?

A. Yes and no. Duke Energy's "Base" forecast predicts increasing annual incremental savings in the short term followed by a roughly 15-year decline in annual incremental savings. Even the "High" EE forecast is just below the average savings level achieved in 2018 by peer utilities as reviewed in the American Council for an Energy Efficiency's 2020 Utility Energy

[67] Although this response was confidential, counsel for Duke Energy confirmed that Figure 2 could be presented in the public, unredacted version of this testimony.

Efficiency Scorecard.[68] However, DEC and DEP's energy efficiency savings performance comes in below more than 20 of its large utility peers, including Entergy in Arkansas, Xcel in Colorado, MidAmerican in Iowa, and Duke Energy in Ohio.[69] Importantly, while these scorecards are useful benchmarks, they are only a snapshot of recent achievements, and do not capture anticipated future energy efficiency savings driven by policy changes, technology improvements, or other factors.

Q. HOW DID SYNAPSE GENERATE ITS ENERGY EFFICIENCY FORECAST USED IN THE *CARBON-FREE BY 2050* SCENARIOS?

A. Synapse identified 1.5 percent of retail load as an appropriate long-term incremental savings target for DEC and DEP to maximize customer benefits from cost-effective energy efficiency. The *Carbon-Free by 2050* scenarios use a 1.5 percent incremental savings target because it represented an achievable increase in energy efficiency savings, in line with peer utilities.[70] Multiple policy developments since 2020, including decoupling via HB 951 and the energy efficiency elements of the IRA, have also paved the way for more energy efficiency in the Carolinas.[71] Synapse proportionally scaled Duke's existing utility energy efficiency programs and

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[68] Relf, G., Cooper, E. Goyal, A., Waters, C. (2020, February). 2020 Utility Energy Efficiency Scorecard. American Council for an Energy Efficient Economy. P.26. Retrieved at: https://www.aceee.org/sites/default/files/pdfs/u2004%20rev_0.pdf.
[69] *Ibid.*
[70] 13 out of the 52 surveyed utilities achieved incremental savings of 1.5% or more in 2018, according to the ACEEE 2020 Utility Energy Efficiency Scorecard.
[71] *See:* Ungar, L. & Ratner, A. (2022, August). Congress Is Set to Vote on the Largest Efficiency Investments in History. *American Council for an Energy-Efficient Economy.* Retrieved at: https://www.aceee.org/blog-post/2022/08/congress-set-vote-largest-efficiency-investments-history.

costs to meet that target.[72] The result of using Synapse's forecast is that the *Carbon-Free by 2050* scenarios maximize ratepayer savings from cost-effective energy efficiency resources.

Q. WERE THERE ANY OTHER DIFFERENCES IN DEMAND-SIDE RESOURCES BETWEEN THE SCENARIOS YOU MODELED IN *CARBON-FREE BY 2050* AND DUKE ENERGY CARBON PLAN SCENARIOS?

A. Yes. Synapse's load forecast relies on Duke Energy's "High" rooftop solar deployment projections, rather than the Company's base projection. Duke explains that the "High" rooftop solar sensitivity is intended to represent continued policy support for this resource, including the extension of the investment tax credit ("ITC").[73] Given the extension of the ITC via the IRA, Synapse's use of the Duke high forecast is warranted. In EnCompass, this additional demand-side solar functions as a reduction to aggregate load during the hours where solar PV is generating.[74]

Q. WHAT WERE THE IMPACTS OF INCREASED ENERGY EFFICIENCY ON THE *CARBON-FREE BY 2050* SCENARIOS?

A. To quantify the benefit of energy efficiency in the *Carbon-Free by* 2050 scenarios and assess how the *Optimized* scenario would respond to lower demand-side savings, Synapse evaluated a low energy efficiency sensitivity which reduced incremental savings from 1.5 percent to 1 percent

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[72] The *Carbon-Free by 2050* report's Appendix A includes a discussion of Synapse's energy efficiency forecast methodology on pages A6-A8.
[73] Appendix E, p. 17.
[74] The *Carbon-Free by 2050* report's Appendix A includes a discussion of Synapse's rooftop solar forecast.

of retail load. Table 2 shows the net present value revenue requirement for the base *Optimized* scenario and the low-EE sensitivity.

Table 7: Impact of Energy Efficiency on Optimized Results

Results (2022-2050)	*Optimized*	*Optimized Low EE*
2030 NPVRR ($B)	$36.0	$36.0
2040 NPVRR ($B)	$69.8	$71.0
2050 NPVRR ($B)	$103.5	$106.4

While the *Optimized* scenario and *Optimized Low EE* sensitivity are roughly equivalent in the earliest years, the 1.5 percent energy efficiency target saves customers $2.9 billion on a net present value basis over time compared to the *Optimized Low EE* sensitivity.

Q. SUMMARIZE AND RESPOND TO DUKE ENERGY WITNESSES' DISCUSSION OF SYNAPSE'S DEMAND-SIDE MODELING ASSUMPTIONS.

A. Duke Energy criticizes Synapse (and other intervenors) for assuming higher levels of EE savings and behind-the-meter solar PV adoption, and therefore lower net load than in Duke's base case.[75] While Duke claims that these projections are overly optimistic and may not be achievable, evidence supports the higher projections for both energy efficiency and behind-the-meter-solar. For energy efficiency, the Companies are expected to achieve incremental savings of one percent of retail load in the short term, even without any additional programming toward a long-term goal.[76] For behind-the-meter solar, the Companies characterize their "High" projection as

[75] Snider et al., page 186.
[76] Carbon-Free by 2050 Report Appendix A, p. A-7.

representing a future in which policy developments such as an extension of the ITC would continue to support rooftop solar growth in the Carolinas; this policy development has occurred as a part of the passage of the IRA.[77]

Duke also incorrectly claims that demand-side resource projections pose a unique risk to system reliability.[78] Integrated resource planning contemplates procurement of demand- *and* supply-side resources with a relatively long planning horizon and an iterative cadence. Reconciling actual versus projected demand-side resource procurement is a routine part of resource planning, just as IRPs might evolve based on real-world adjustments to supply-side procurement (e.g., construction delays of non-commercialized nuclear resources). As described above, evidence supports the projections used in the *Carbon-Free by 2050* report as reasonable for the purposes of the Carbon Plan. Using unreasonably low projections would artificially suppress the contribution of demand-side resources to "shrinking the challenge" of reducing carbon emissions while meeting energy and capacity needs and maintaining reliability.

Q. PLEASE SUMMARIZE YOUR FINDINGS AND RECOMMENDATIONS REGARDING DEMAND-SIDE RESOURCES.

A. My analysis shows that additional investment in demand-side resources can save North Carolina ratepayers billions of dollars in the long-term. This

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[77] Friedman, S., Stoel, J., Sullivan, M. A., Wickett, J., & Lovelis, H. (2022, August). The IRA's transformative tax incentives for solar energy projects and manufacturing operations. *JD Supra.* Retrieved at: https://www.jdsupra.com/legalnews/the-ira-s-transformative-tax-incentives-4082010/.
[78] Snider et al., p. 189, ll. 8-13.

position is supported by other intervenors, including the Attorney General[79] and Tech Customers.[80] Therefore, I recommend that the Commission integrate higher energy efficiency and behind-the-meter solar forecasts in its Carbon Plan, and direct the Companies to develop programs that are able to accommodate these increased forecasts.

Q. DO YOU HAVE ANY COMMENTS ON INCLUDING ENERGY EFFICIENCY AS A SELECTABLE RESOURCE IN RESOURCE PLANNING MODELING?

A. When adequate pricing, timing, and deployment information is available and efficiency programs are suitably flexible, including energy efficiency as a selectable resource in modeling can provide an even greater level of precision in resource planning. The Attorney General recommends in the Strategen report that Duke allow EnCompass to select demand-side resources as a potential resource in future plans.[81] The results of Synapse's analysis in the *Carbon-Free by 2050* report indicate that additional energy efficiency is cost-effective for North Carolina ratepayers; I would expect that if selectable energy efficiency resources were appropriately configured in the EnCompass model, it would select incremental efficiency beyond the Companies' 1 percent of retail load target.

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[79] AGO Strategen report, pages 41-45.
[80] Tech Customers Gabel report, pages 37-42.
[81] AGO Strategen report, pages 41-42.

VII. <u>Issues related to “Cost.”</u>

B. The Carbon-Free by 2050 Report’s Revised NPVRR Projections Finds that Duke’s $P1_A$ Portfolio is the Most Expensive for Ratepayers.

Q. DID SYNAPSE MODEL ANY OF DUKE’S SCENARIOS IN THE *CARBON-FREE BY 2050* REPORT?

A. Yes. Synapse modeled the set of resources identified by the $P1_A$ portfolio identified in Duke’s proposed carbon plan filing. These results are presented in the *Duke Resources* scenario in the *Carbon-Free by 2050* report.

Q. BRIEFLY SUMMARIZE THE REVISED INPUTS THAT SYNAPSE MADE IN ITS *CARBON-FREE BY 2050* REPORT THAT AFFECTED ANALYSIS OF THE *DUKE RESOURCES* SCENARIO.

A. Synapse made several revisions to the cost inputs that affect net-present-value revenue requirement projections for the *Duke Resources*. These include:

1. Revised gas and hydrogen price forecasts, as discussed above;
2. Revised capital expenditure projections for all candidate resources, as discussed above; and
3. Revised fixed operations and maintenance costs and ongoing capital investments for existing coal plants, as discussed above.[82]

Q. HOW DID THESE REVISIONS AFFECT THE COST PROJECTIONS?

A. Based on these revisions, Synapse’s analysis found that the $P1_A$ portfolio would cost ratepayers considerably more than what Duke projected in their proposed carbon plan filing. Table 7, below, compares Duke’s net-present-

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[82] Pages 9-12 of the *Carbon-Free by 2050 Report* present a comprehensive list of revisions made by Synapse to EnCompass inputs.

value revenue requirement projection for portfolios $P1_A$ with that created by Synapse in the *Carbon-Free by 2050* report.

Table 8. Net Present Value Revenue Requirement for $P1_A$, Duke vs. Synapse

Results (2022-2050)	NPVRR
Duke Energy Carbon Plan Filing – $P1_A$	$104.1
Carbon-Free by 2050 Report – Duke Resources	$121.2

Source: Duke Energy Carbon Plan Appendix E, p. 90 and Carbon-Free by 2050, p. 24.[83]

Q. HOW DOES THAT COMPARE WITH OTHER SYNAPSE SCENARIOS IN THE *CARBON-FREE BY 2050* REPORT?

A. In the *Carbon-Free by 2050* report, we found that the *Optimized* and *Regional Resources* portfolios were substantially more cost-effective than the *Duke Resources* portfolio. Table 8, below, shows net-present-value revenue requirement for each of the portfolios over time.

Table 9. Net Present Value Revenue Requirement over Time by Scenario

Results (2022-2050)	*Duke Resources*	*Optimized*	*Regional Resources*
2030 NPVRR ($B)	$36.7	$36.0	$34.3
2040 NPVRR ($B)	$77.7	$69.8	$65.8
2050 NPVRR ($B)	$121.2	$103.5	$98.1

Source: Carbon-Free by 2050, p. 22.

In the short and long term, the *Duke Resources* portfolio, which mimics the resources from Duke's proposed $P1_A$, costs substantially more to ratepayers than either the *Optimized* or *Regional Resources* portfolio.

Q. DOES THAT CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

[83] Minor differences may result from different methodologies for aggregating costs for NPVRR.

CERTIFICATE OF SERVICE

I certify that the parties of record on the service list have been served with the Direct Testimony of Tyler Fitch on behalf of North Carolina Sustainable Energy Association, Southern Alliance for Clean Energy, Natural Resources Defense Council, and the Sierra Club either by electronic mail or by deposit in the U.S. Mail, postage prepaid.

This the 2nd day of September, 2022.

s/ Gudrun Thompson

Gudrun Thompson

Synapse Energy Economics, Inc.

Tyler Fitch, Senior Associate

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PROFESSIONAL EXPERIENCE

Synapse Energy Economics Inc., Washington, DC. *Senior Associate*, November 2021 – Present.

Conducts regulatory analysis and provides expert testimony on energy & climate issues. Examples include:

- Evaluating utility proposals for additional generation infrastructure against more economic and less carbon-intensive alternatives;
- Assessing the economic viability and prudence of continued operations of legacy coal plants as opposed to alternative resources and market purchases.

Vote Solar, Washington, DC. *Regulatory Director,* February – November 2021; *Regulatory Manager,* August 2018 – February 2021.

Regulatory Director:

- Directed Vote Solar's climate and clean energy regulatory advocacy in the Carolinas, including public-facing reports and webinars; directing regulatory litigation; managing professional services and consultants; and developing advocacy in coalition with clean energy, environmental, and environmental justice stakeholders.
- Authored a technical report assessing stranded asset risk of electric generation infrastructure as a result of corporate carbon neutrality commitments. Results quoted in *Bloomberg, S&P,* and *GreenTechMedia.*
- Implemented a settlement with Duke Energy to conduct a region-leading investigation into physical climate-related impacts to electricity infrastructure in the Carolinas.
- Provided expert testimony in utility integrated resource planning proceedings identifying emergent climate-related risks and implications for utility planning, then providing recommendations for utility resource planning moving forward.

Regulatory Manager:

- Developed nation-leading quantitative assessment and regulatory direction for responding to the increase in residential utility debts as a result of COVID-19.
- Provided expert testimony on best practices in grid modernization in the context of climate-related physical risks to the North Carolina Utilities Commission.
- Provided expert testimony on utility rate design to the Virginia State Corporation Commission and Georgia Public Service Commission.

- Developed a flexible spreadsheet-based tool for assessing solar value proposition across several different rate design and project cost sensitivities.

The University of Michigan, Ann Arbor, MI. *Research Assistant, Urban Energy Justice Lab*, September 2016 – May 2018.

ICF International, Fairfax, VA. *Analyst*, October 2013 – June 2016.

- Developed energy efficiency scores for *ENERGY STAR* buildings using large data sets and multiple linear regression.
- As data lead for the multifamily sector of the *Better Buildings Challenge* wrote data policy and managed data submission for 100+ partners, spanning hundreds of buildings across the country.

EDUCATION

The University of Michigan, Ann Arbor, MI
Master of Science, School of Natural Resources and the Environment, 2018
Masters Project: *Fueling a Transition: Evaluating the Feasibility for a Hybrid Renewable Microgrid in Beni, Democratic Republic of Congo*

University of North Carolina, Chapel Hill, NC
Bachelor of Science, 2013
Environmental Science, Focus: Energy and Sustainability; Minor: Computer Science

PUBLICATIONS

Fitch, T., Kwok, S., Kalley, J., & Chang, M. 2022. *Designing Effective Electric Grid Resiliency Plans: Brief for Decisionmakers in Entergy New Orleans' Resiliency Planning Process.*

Fitch, T. 2021. *Carbon Stranding Briefing: Risks of Carbon Stranding in Duke Energy's Modified 2020 Integrated Resource Plan*. Vote Solar.

Fitch, T. 2021. *Initial Comments to South Carolina Public Service Commission on Measures to Be Taken to Mitigate Impact of Threats to Safe and Reliable Utility Service.* Vote Solar.

Fitch, T. 2021. *Partial Proposed Order to South Carolina Public Service Commission, related to Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's 2020 Integrated Resource Plans.* Vote Solar.

Fitch, T. 2021. *Initial Comments to North Carolina Utilities Commission in the Matter of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's 2020 Integrated Resource Plans.* Vote Solar.

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Fitch, T. 2020. *COVID-19 and the Utility Bill Debt Crisis.* Vote Solar.

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Fitch, T. 2018. *Islands of Light: Microgrids and the Public Good.* Agora Planning Journal, 12, 74-80.

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Fitch, T., Lenhart, A., Buchanan, C., & Jeong, B. 2018. *Get Free: Understanding the Potential for Community Solar Power in Highland Park.* Dow Sustainability Report Series.

TESTIMONY

Georgia Public Service Commission (Docket No. 44160): Direct Testimony of Tyler Fitch in the matter of Georgia Power Company's 2021 Integrated Resources Plan. May 4, 2022.

South Carolina Public Service Commission (Docket Nos. 2019-224-E and 2019-225-E): Surrebuttal Testimony of Tyler Fitch in the matter of the 2020 Integrated Resource Plans for Duke Energy Carolinas, LLC and Duke Energy Progress, LLC. April 15, 2021.

South Carolina Public Service Commission (Docket Nos. 2019-224-E and 2019-225-E): Direct Testimony of Tyler Fitch in the matter of the 2020 Integrated Resource Plans for Duke Energy Carolinas, LLC and Duke Energy Progress, LLC. February 5, 2021.

North Carolina Utilities Commission (Docket No. E-2, Sub 1219): Direct Testimony of James Van Nostrand and Tyler Fitch in the Matter of Application of Duke Energy Progress, LLC for Adjustment of Rates and Charges Applicable to Electric Service in North Carolina. April 13, 2020.

Virginia State Corporation Commission (Docket No. PUR-2019-00214): Direct Testimony of Tyler Fitch in the matter of the Application of Virginia Electric and Power Company for approval to establish an experimental residential rate. March 31, 2020.

North Carolina Utilities Commission (Docket No. E-7, Sub 1214): Direct Testimony of James Van Nostrand and Tyler Fitch in the Matter of Application of Duke Energy Carolinas, LLC for Adjustment of Rates and Charges Applicable to Electric Service in North Carolina. February 18, 2020.

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